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Cover: Two articles in this issue, pages 91 and 93, cover NBS contributions to the efficiency of the nation's electrical power network.

U.S. DEPARTMENT OF COMMERCE
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Richard O. Simpson
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NATIONAL BUREAU OF STANDARDS
Richard W. Roberts, Director

Prepared by the NBS Office of Technical Information and Publications, Washington, D.C. 20234

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards

The Institute for Materials Research

The Institute for Applied Technology

The Institute for Computer Sciences and Technology

Center for Radiation Research

Center for Building Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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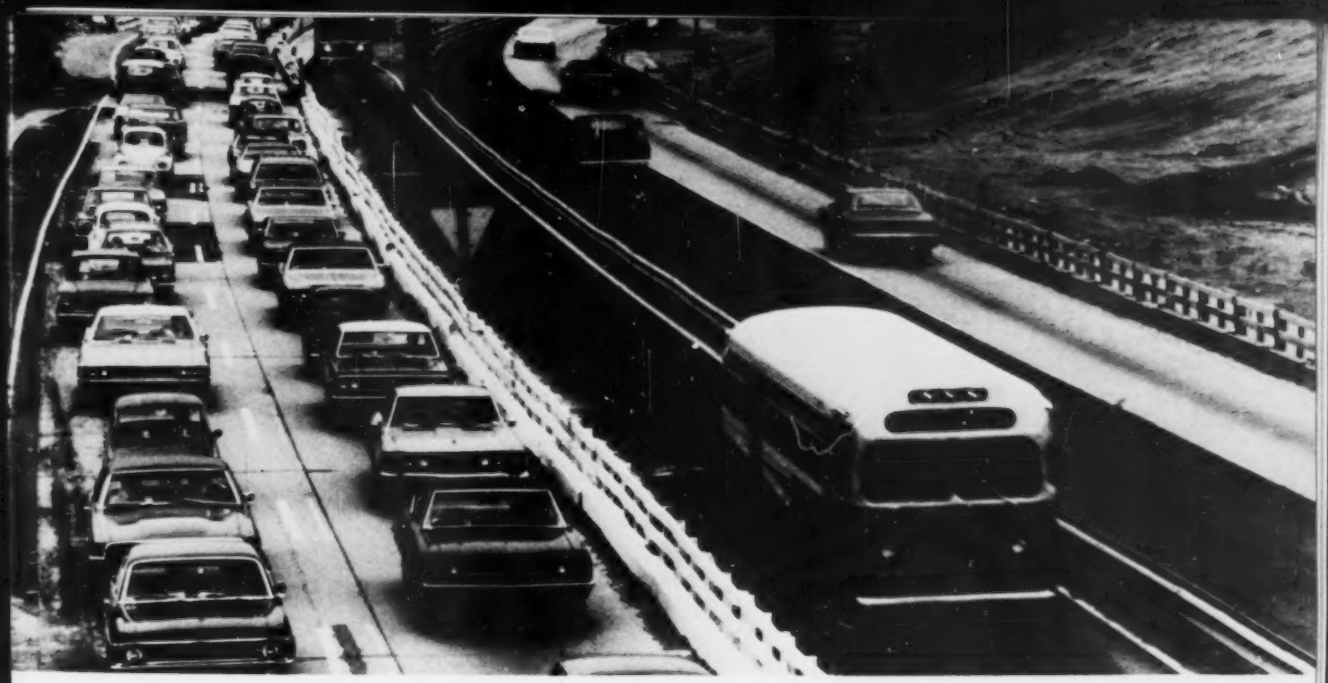


Shirley Highway, Va., during rush hour, showing an express lane for buses.

NBS EVALUATES EXPRESS BUS PROJECT

An experimental bus project on Virginia's Shirley Highway has significantly affected commuter travel patterns, according to a Bureau study. NBS has determined that since 1969, when the project began, over 5,000 additional daily patrons have been attracted to the bus service. As a consequence, it is estimated that 3,000 fewer cars travel inbound daily on the congested highways. This has meant a corresponding reduction in peak period air pollution of about 1,700 tons of pollutants annually. In the March and June 1972 a.m. peak periods, the exclusive busway lane carried between 500 and 1,000 more people than the two Shirley Highway auto lanes combined.

Jointly sponsored by the Urban Mass Transportation and Federal Highway Administrations, Department of Transportation, the Shirley Highway Express-Bus-On-Freeway Demonstration Project seeks to demonstrate the effectiveness of three elements: exclusive bus lanes, new feature buses, and fringe parking facilities coordinated with the express bus service.

To facilitate the transferability of bus-on-freeway technology to similar projects in other regions of the United States, analysts in the NBS Technical Analysis Division monitor project performance and seek to determine which of these elements increase the use of buses by commuters, and by how much.[1]

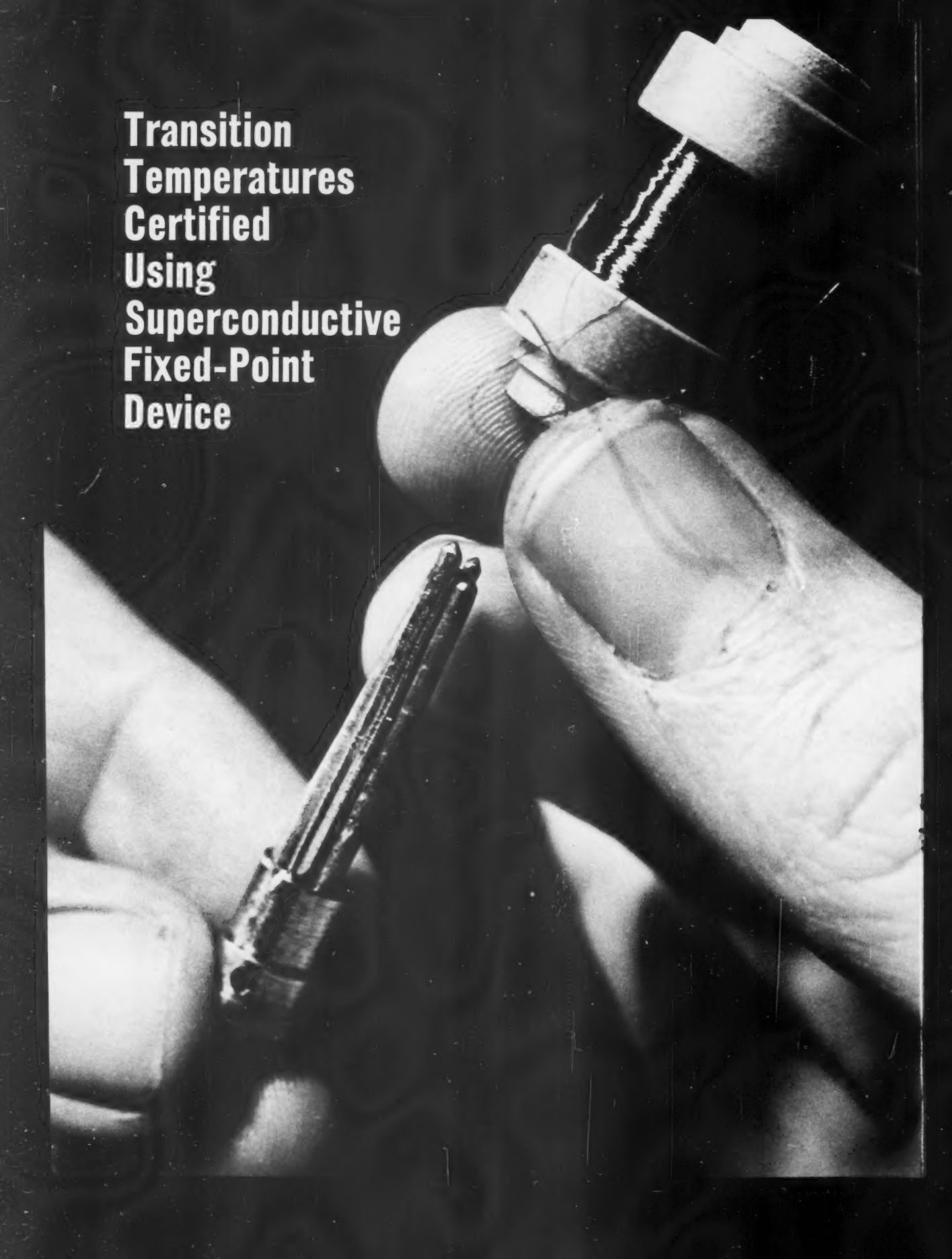
Shirley Highway is a major radial freeway serving a Corridor population of more than 500,000. The highway emanates from Washington, D.C., into northern Virginia and serves the Pentagon and Crystal City complexes. The busway is located in the median of the freeway, which is currently being converted from four to eight lanes. This is the first large scale demonstration of the bus-on-freeway technology.

Preliminary results reported by NBS have not yet been related to the costs of providing the new bus-on-freeway service. As the project proceeds toward its 1975 completion date, NBS analysts will seek to determine who benefits, in what ways, and by how much; and will relate these benefits to the costs.

The Technical Analysis Division has been involved in other major transportation studies including the Northeast Corridor Transportation Study and developing a national rail network program for waybill processing. The Urban Systems Program Area within the Division is concerned with applying system analysis techniques to problems of national significance in the areas of transportation and urban information systems.

[1] The Shirley Highway Express-Bus-On-Freeway Demonstration Project—First Year Results, by Gerald K. Miller and Keith M. Goodman. This is the second in a series of interim reports published by the Department of Transportation.

Transition Temperatures Certified Using Superconductive Fixed-Point Device



■ A superconductive device, providing five fixed-point reference temperatures near absolute zero, has been developed at the Bureau. It should be widely useful in the fast-growing cryogenics field for calibrating helium dilution refrigerators, determining the temperature stability of equipment and the temperature reproducibility of physical phenomena, and providing *in situ* calibration of secondary thermometers. Its most important aspects, however, may lie in its use in helping to define the thermodynamic temperature scale below 20 K, and in demonstrating the feasibility of solid-state phenomena as thermometric fixed points.

James Schooley, Robert Soulen, Jr., and George Evans, Jr., members of the Heat Division of the Institute for Basic Standards, certify that each superconductive fixed-point device will reproduce its transition temperatures within 1 millikelvin under laboratory conditions. Composed of five high-purity elements—lead, indium, aluminum, zinc, and cadmium—the device provides fixed points near 7.2 K, 3.4 K, 1.2 K, 0.8 K, and 0.5 K.[1,2] Designated SRM 767, these devices are available through the NBS Office of Standard Reference Materials for $250.[3]

Cylinders of the five elements are mounted in a threaded copper stud and enclosed by a mutual inductance coil set—producing a unit only 1.5 cm in diameter and 4 cm long. In use, the copper stud is connected thermally to the thermometer to be calibrated or to the experimental chamber, and the four mutual inductance coil leads are connected to a mutual inductance bridge. The superconductive transitions can be monitored easily by mutual inductance measurements. Neither the measuring field nor the local magnetic field should exceed 1 μT (0.01 gauss), however, as superconductive transition temperatures are field-dependent.

Many metals lose all traces of electrical resistance, i.e., they become superconductors, at temperatures near absolute zero. Providing that metals could be found in which the transition to the superconductive state would take place over a very narrow temperature range, and providing also that the transitions would occur reproducibly in spite of necessary laboratory handling, superconductors could furnish fixed points to define the extension of the International Practical Temperature Scale below its present limit of 13.81 K. In addition, the compact and inexpensive nature of fixed-point devices based on phase transitions occurring entirely within the solid state would permit the almost routine use of such devices in many types of cryogenic apparatus.

The Institute scientists were aided considerably in their efforts by the NBS Office of Standard Reference Materials. Through Robert Michaelis, OSRM provided both financial support and supplies of very pure, well-characterized aluminum, zinc, and cadmium. Richard Reed and Maurice Kasen of the Cryogenics Division, also part of the Institute for Basic Standards, helped with the problem as well, furnishing special low-resistance samples of aluminum for comparison with the OSRM supplies.

Working with wire-shaped, annealed samples of the high-purity, soft elements, Schooley, Soulen, and Evans found that narrow and

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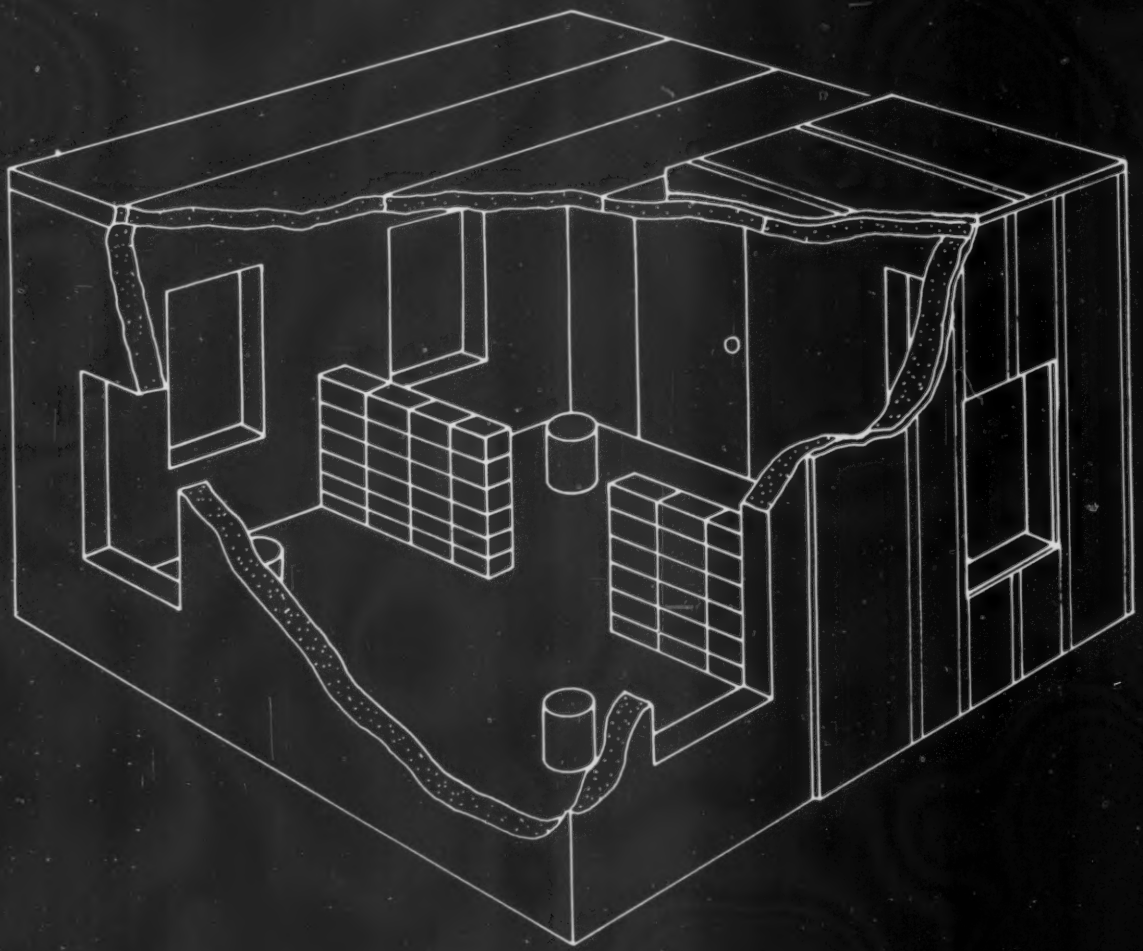
In gratitude for the aid given by the NBS Cryogenics Division in the development of SRM 767, one of the first sets was given to Dudley Chelton, Cryogenics Divison Chief, by Ralph Hudson, Chief of the Heat Division, for use in the Boulder laboratory's cryogenics program.

Superconductive fixed-point device. Cylinders of the five elements are mounted in a threaded copper stud (left). In use they are enclosed in a mutual inductance coil set (right) and the copper stud is connected thermally to the thermometer or chamber to be calibrated.

ENVIRONMENTAL TESTING OF FULL SIZE BUILDINGS



■Investigations show that current methods of calculation may lead to overdesign of heating and air conditioning equipment by as much as 30 percent. The research also showed that, with the masonry structure tested, the same insulation was more effective when placed on the outside, rather than on the inside of the building.

Building materials and methods of construction are major cost factors in new buildings, and fuel consumption constitutes a long-term expense in operating a building. The Bureau's work is expected to lead to substantial reductions in costs of building construction, now estimated to cost about $70 billion yearly.

Using one of the Nation's largest and most versatile environmental test chambers—nearly 70,000 cubic feet in volume—Bureau scientists studied the flow of heat into and out of a full size masonry building erected within the chamber. Two basic tests were performed with the chamber, whose temperature can be varied from minus 50 °F to plus 150 °F with appropriate humidity within this range. The first was a floating test in which no energy was added to the building while "outdoor" temperatures varied between 40 and 100 °F each day. In the second "thermostated" tests the experimental building was exposed to the same outdoor air-temperature cycle while indoor air temperature was maintained within ±1 °F by four electric fan heaters.

TEST BUILDING

For the test, conducted by Bradley A. Peavy, Jr., Frank J. Powell, and Douglas M. Burch of the NBS Center for Building Technology, a full size one-room house, measuring 20 feet wide, 20 feet long, and 10 feet high, was built inside the environmental test chamber at the Gaithersburg, Md., laboratory. The walls of the house were made of cinder aggregate blocks, with a roof of reinforced concrete slabs.

In some tests an indoor mass of 2,600 pounds of concrete block was stacked on the floor to simulate the effect of interior furniture and household contents. For tests using insulation, 2-inch thick polystyrene board-type insulation was spot glued to the inside or outside surfaces of the building.

Several features of the building, such as window arrangement, amount and location of insulation, and indoor mass, were varied during the experiment to determine thermal effects on the building caused by these changes. In all cases measured values of temperature and heat transfer were compared with the corresponding values predicted by a special computer program (named NBSLD for *N*ational *B*ureau of *S*tandards *L*oad *D*etermination).

EXPERIMENTAL RESULTS

The tests showed experimentally that the NBS-produced computer program (NBSLD) could predict a building's response to daily and seasonal weather patterns. The test also verified theoretical predictions where thermal reactions depending on time took place within the masonry building itself.

Equally important, the tests demonstrated that insulation on the *outside* of masonry buildings was very effective in reducing and controlling inside air temperature variations—an effect also predicted by NBSLD. When inside temperature was not thermostated and the building temperature floated in response to outside air temperature variations, insulation on the *inside* building surfaces reduced inside temperature variations from 10 to 5.5 °F. When the same insulation was placed on the *outside* of the building the inside air temperature variation was reduced to about 2 °F. Comparing cases of no insulation, insulation inside, and insulation outside, temperature differences on the walls from floor to ceiling and temperature differences of the indoor air were lowest when insulation was placed on the *outside* of the building.

The effect of an indoor mass on thermal behavior of the test building was small. For tests in which the variation of inside temperature was small, as in the thermostated phase, the effect of an indoor mass was practically negligible. The experiment also proved the NBSLD computer program's ability to predict the daily air temperature profile as it is influenced by known outdoor temperature conditions and the effect of the mass and thermal resistance of the experimental building. In addition, when inside air was thermostated, NBSLD was able to predict peak and daily average loads; it may therefore be used to predict energy requirements and enable designers to more accurately choose equipment needed to condition the interior of a building.

Finally, the study disclosed that traditional steady-state techniques of heat load calculation could result in oversizing heat equipment by as much as 30 percent. The new NBSLD dynamic program takes into account heat storage effects and therefore predicts the peak heating and cooling load more realistically than was heretofore possible. The maximum difference between computer-calculated peak heating load and measured values was 6 percent and the average difference was 3.5 percent for five tests.

Cutaway view of interior of test structure showing one configuration of windows and internal masses.

OPTICAL RADIATION NEWS

PROGRAM FOR RADIOMETRY AND PHOTOMETRY

The Optical Radiation Section has adopted a 5-year program in radiometry and photometry which is designed to meet the needs of the electro-optics community. The schedule attempts to meet the most pressing demands for the accurate measurement of incoherent electromagnetic radiation in the spectral region between microwaves and the vacuum UV (100 μm to 200 nm). The program is based on an extensive issue study of the field,[1] the report of the Council for Optical Radiation Measurement (CORM),[2] and currently available funds and manpower. The program is subject to modification as priorities change or new needs are revealed, and indeed has been modified since its inception less than a year ago.

The number of new optical radiation standards, calibrations, measurement techniques, and documentations requested of NBS is enormous. Those identified in the CORM report alone could not be satisfied in 5 years, even if the radiometry and photometry staff were doubled. This excessive demand requires that the NBS program in radiometry and photometry be carefully selected and optimized.

The three basic elements of the program, in order of priority, are:

1. Establishment and maintenance of the primary scales, and their dissemination through calibrations.

2. Development and operation of a Measurement Assurance Program (MAP).

3. Development of secondary measurement techniques and characterization of apparatus components.

SCALES

Agreement among radiometric and photometric measurements made at different times and places, and in different manners, throughout the National Measurement System (NMS), can only be realized through use of a consistent system of scales. Such a unique base must be available to all, and have a long-term stability significantly greater than the best agreement required. The need for such agreement dictates that the highest priority be assigned to the establishment of the primary scales and their dissemination through readily available calibrations.

The radiometric and photometric scales of greatest need in the NMS at this time are spectral radiance, spectral irradiance, irradiance, luminous intensity, and luminous flux.

Spectral radiance is usually considered the most fundamental radiometric quantity—all other radiometric quantities can be derived from it. It is the quantity directly obtainable from a blackbody and a temperature measurement.

The existing capability at NBS for realizing a scale of spectral radiance and for performing calibrations associated with this scale is very close to what the CORM report has requested (1—2 percent depending on wavelength). What is lacking is a capability associated with temperatures ranging from 170 to 350 K and wavelengths beyond 15 μm. Also the time and cost required to realize, maintain, and disseminate the NBS scale are great. For example, a typical calibration requires 1 to 2 weeks and costs $1,350 to $2,600.

At present, the NBS program consists of realizing the spectral radiance scale periodically for the purpose of establishing an improved scale of spectral irradiance, extending it further into the infrared, and extensively documenting procedures and uncertainties in performing calibrations with it. The 5-year program calls for automating the realization and dissemination of the scale, starting next fiscal year. This should reduce significantly the cost, and make a MAP effort practicable.

The *spectral irradiance* scale at NBS is derived from the spectral radiance scale, and spectral irradiance is probably the most frequently used radiometric quantity. We have recently realized an improved spectral irradiance scale from 250 to 1,600 nm (3—1 percent) and expect to cover 200—2,500 nm in 6 months to a year.

In the near future, the new spectral irradiance scale will be used

(1) in an international comparison with other national laboratories,

(2) in realizing a new scale of color temperature which is expected to be more accurate than the present scale by a factor of about five, and

(3) in determining the maximum spectral luminous efficacy (K_m) associated with the NBS scale of luminous intensity.

Item (3) is motivated by the requirement by various parts of the NMS of converting readily from radiometric

to photometric units. It is also an important first step in any eventual redefinition of photometric units based on spectroradiometry.

Work on automating the realization and dissemination of the spectral irradiance scale will start next fiscal year.

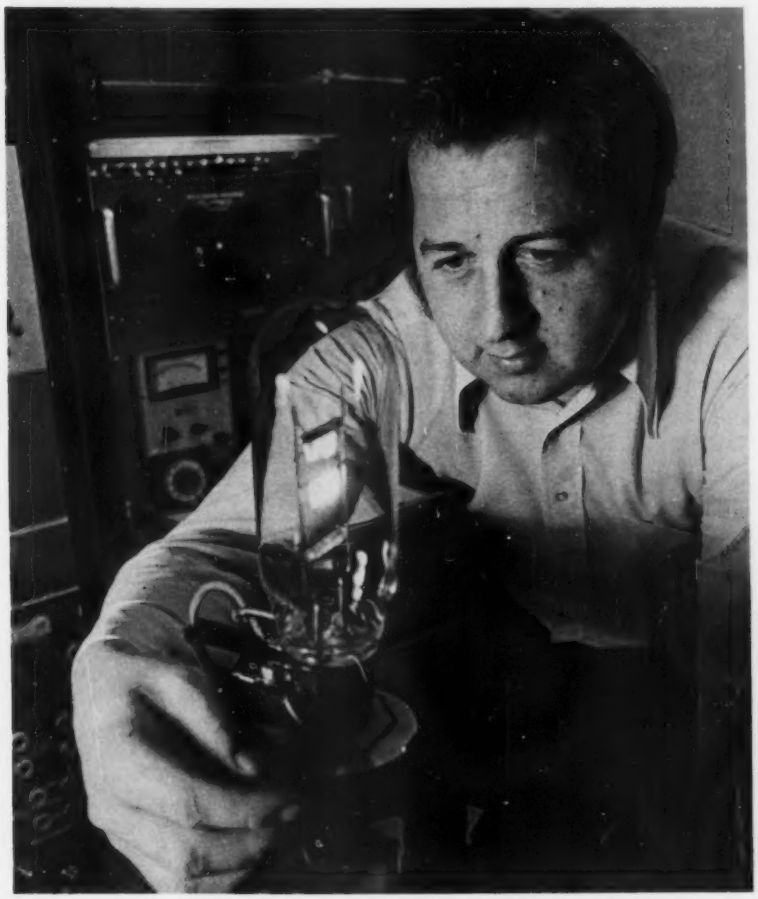
Irradiance is the simplest, least expensive radiometric calibration, and is widely used when spectral information is not required.

Whereas the old NBS scale of irradiance had been realized with a blackbody and temperature measurements, a new scale is being developed based on a cavity detector (or radiometer) that contains an electrical heater and which has been designed to respond "equivalently" to radiant or electrical heating. Thus it is calibrated by electrical measurements. Such a device has been referred to as an absolute detector, but at NBS we have begun to refer to it with a more descriptive name—an electrically calibrated radiometer (ECR).

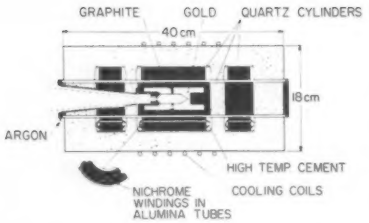
During the past year the new scale of irradiance has been realized from about 30 mW/cm^2 to 140 mW/cm^2 with an uncertainty of about 1/2 percent. Differences between this scale and the older blackbody-derived irradiance scale have been determined to be about 1.5 percent at the low level and 2.5 percent at the upper level. A recent comparison of the new scale with the laser power and energy scale, maintained at NBS Boulder, showed a difference in the two scales of about 0.1 percent, and the total uncertainty of the comparison was 1.6 percent.

Extension of the irradiance scale to the 1 $\mu W/cm^2$ level is now being initiated. It appears that this can best be achieved through an electrically calibrated cavity pyroelectric radiometer. Development of such a device, without the cavity, for laser measurements at the Boulder Laboratories has been extremely encouraging. This approach will be pursued vigorously during the coming year. Because this type of detector has a much shorter time constant than the 30 seconds of our ECR's and still can be calibrated by electrical measurements, it is expected to have many applications in incoherent radiometry in addition to realizing a scale of irradiance.

Luminous intensity is currently considered the fundamental photometric quantity. In addition to being widely used, it is the only radiometric or photometric quantity included as one of the base units in the International System of Units (SI). However, this SI definition based on a platinum-point blackbody has been very inefficient and expensive to realize. As a result, national standards laboratories throughout the world, including NBS, have performed this realization very infrequently (one or two times in 30 years is typical), and the luminous intensity scale has been maintained on groups of lamps. For all practical purposes, the lamps are themselves the scale. If the lamps change, the scale changes. A scale or standard such as this is referred to as a gage. To ensure some sort of uniformity between the national standards laboratories, international comparisons relative to these lamp groups have been conducted



Jim Maness orients an NBS standard of luminous intensity. After the luminous intensity of this lamp is measured on the photometer bar a test lamp will be substituted and measured.



NBS gold-point blackbody used to establish a temperature scale for radiometry. The gold point temperature is 1064.43 °C.

about every 4 to 8 years. The typical range in the results of these comparisons has been about 2 percent. A recent effort[3] to estimate the uncertainty of the NBS scale of luminous intensity relative to its SI definition resulted in a value of 4 percent. The experimental evidence for this estimate is quite limited, however, making the uncertainty of the estimate very high.

Our 5-year program includes attempting to realize an SI uncertainty for luminous intensity of 1 percent. Extensive investigations have been performed seeking more reproducible and stable lamps, and improved techniques for using these lamps have been developed. Considerable progress has also been made on the development of a new, more precise and easy-to-use platinum-point blackbody. However, as a result of the recent sudden death of our blackbody expert (R. D. Lee), and the somewhat lower priority CORM has given the improvement of this scale, we are postponing its new SI realization. We do expect, as mentioned earlier, to determine the K_m associated with the NBS luminous intensity gage scale using the newly realized spectral irradiance scale. This will put the scale on a well-documented experimental base with an uncertainty relative to absolute radiometric units of about 2 percent and a long-term NBS reproducibility of about 1 percent.

A scale of *luminous flux* is usually realized using a distribution photometer and a normalization to the luminous intensity scale. As in the case of the platinum-point blackbody, however, the distribution photometer has been a tedious and expensive instrument to use, and therefore national standards laboratories have realized the luminous flux scale infrequently. It too has become largely a gage system. In fact, at NBS, there are currently two gage systems maintained for luminous flux since the low end of the present scale (51-type lamps) has not been compared to the rest of the scale. The SI uncertainty for luminous flux (excluding the 51-type lamps) has been estimated recently[3] to be 5 percent.

A modern distribution photometer is being developed to realize and maintain a scale of luminous flux. Construction of the instrument has been completed and investigation of its characteristics and its random and systematic errors is under way. The aim is to be able to realize the flux scale with an uncertainty not exceeding 1 percent relative to the luminous intensity scale. Concurrently, an Industrial Research Associate (K. Mohan), sponsored by the Lamp Testing Engineers' Conference, is developing the necessary accessory equipment so that a spectral flux scale can also be realized.

CALIBRATIONS

The recently revised calibration policy for radiometry and photometry has been described in an earlier edition of this bulletin (June 1972 TNB). The philosophy of the program is to have a limited number of well-characterized, rapidly available, inexpensive, and sufficiently accurate basic calibrations to satisfy the needs of the National Measurement System.

The objectives of our 5-year program relative to improvements and extensions in NBS calibrations are:

1. Reduction of current uncertainties, on the average, by a factor of two.
2. Thorough description and documentation of each calibration.
3. Reduction of delivery time and cost by a factor of two to four.
4. Issuance of about 25 new calibrations.

During the past year, we have made improvements in 15 of the 25 calibrations currently issued and have significantly expanded the calibration report for luminous intensity, luminous flux, and color temperature.[3] The objective for all calibration reports is to tell clearly how the calibration is performed and to give all the information we have relative to its precision and accuracy.

In the coming year, improvements or expanded reports are expected for spectral radiance, spectral irradiance, irradiance, and color temperature. New calibrations for light emitting diodes (LED's), spectral flux, and low temperature blackbodies are expected to be issued, and development of an instrument for calibrating spectral response of detectors will be initiated.

MEASUREMENT ASSURANCE PROGRAM

The second priority in the NBS radiometry and photometry program is the establishment of a Measurement Assurance Program for determining whether or not the NMS is operating satisfactorily. This would involve various experimental designs to check out the measurement process starting with the standard received from NBS to the final result at the end of the measurement chain. Since this process requires NBS involvement in the detailed application of its calibrations in the users' laboratories, it also provides valuable data to assess the most pressing needs in the measurement system.

In the past year, we were not able, with the budget and staff available, to initiate a Measurement Assurance Program. With DOD

funding, we did start a laboratory intercomparison with the major secondary standards laboratories in DOD involving infrared radiance of blackbodies from 500 to 800 K. Currently we are initiating intercomparisons in luminous intensity and spectral radiance with those industrial and governmental laboratories which feel a pressing need for such an activity.

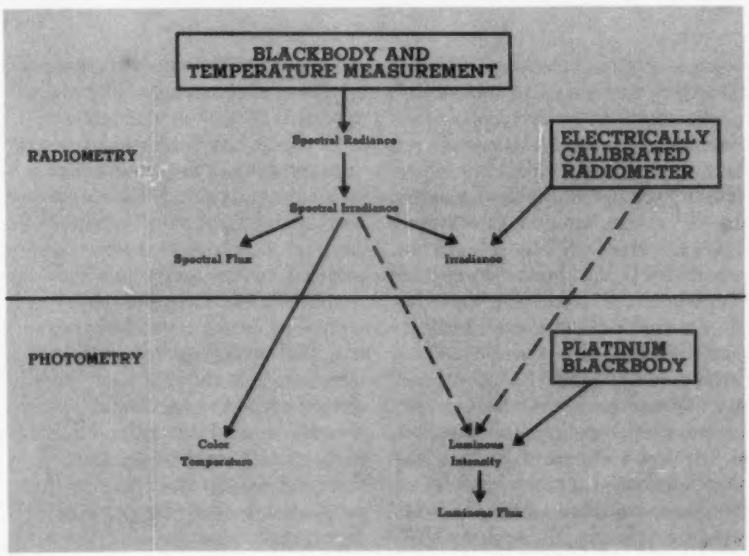
During the coming year, owing to budgetary constraints our MAP efforts will be largely restricted to completing the above-mentioned items and a new round-robin involving spectral irradiance. However, we will be obtaining detailed information on how our calibrations are used throughout the NMS. This information and the experience gained from the DOD intercomparisons will serve as a base on which our MAP effort will be built.

TECHNIQUES AND CHARACTERIZATIONS

The number three priority in the NBS radiometry and photometry program is to characterize or develop the measurement techniques required in applying NBS standards to a wide variety of secondary measurements. This also includes characterizing various apparatus components needed in the measurements—sources, detectors, monochromators, etc. Much of this effort must be shared by other laboratories.

Last year only those component characterizations and measurement techniques required in our scale and calibration programs were investigated. However, this did involve all our major scales. In addition a rather extensive study has been made on a large number of gas-filled, commercial lamps that might be useful as luminous intensity, spectral irradiance, or irradiance standards. A more exact theory has been developed for determining the systematic errors in using integrating spheres for the flux comparison of lamps having a different size, optical absorption, and goniometric distribution. All these investigations will be written up in detail in our Technical Note Series during the next 6 months.

During the coming year, we expect to initiate a project designed primarily to work on the more generally needed measurement techniques in the NMS that are not already being investigated relative to scale realizations or calibration development. Current possibilities are spectral measurement techniques associated with spectral lines and attenuation techniques.



DISSEMINATION OF INFORMATION

There are three types of publications in which the Radiometry and Photometry Group mainly disseminates information to the National Measurement System. One is the traditional scientific journal publication. Another is the NBS Technical Note Series 594 entitled OPTICAL RADIATION MEASUREMENTS which was started during the past year. Any extensive information that we feel is of value to the NMS but is unsuitable for the scientific journals will be published here. A few examples are papers including extensive mathematical or engineering details, tutorial material, and yearly progress reports on lengthy investigations. In a few years we expect to extract suitable information from these Technical Notes and coordinate and amplify it into a Radiometry and Photometry Standards Handbook. The third publication is this bimonthly newsletter of the NBS Technical News Bulletin, The Optical Radiation News, which first appeared in October 1971. Examples of the information contained in this newsletter are announcements of CORM and CIE meetings, announcements of Technical Note Publications, information on our program, on new calibrations and intercomparisons, and brief summaries of technical investigations.

During the past year, three journal articles and four technical notes have been published in addition to these TNB articles and 11 talks were presented at meetings of OSA, IRIS, and other groups.

LONG RANGE GOALS

The 5-year program includes

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NEW KITCHEN RANGE ST

The NBS Fire Technology Division and the Bureau of Product Safety, Department of Health, Education and Welfare, are coordinating an effort by several segments of the kitchen range industry to develop standards that will lead to safer kitchen ranges.

Under this program, the Underwriters' Laboratories (UL) and the American Gas Association (A.G.A.) are spearheading a closely scheduled series of events designed to amend the voluntary standards for gas and electric ranges in order to reduce the risks of fabric fires in the kitchen. A proposed modification is expected to be released by UL for public comment by the end of April. The Subcommittee on Gas Ranges of the American National Standards Institute Committee Z21 is expected to have a proposed standard for gas ranges by late April.

In December 1971, the Fire Technology Division called a meeting of range manufacturers and representatives of UL, A.G.A., the Association of Home Appliance Manufacturers (AHAM), the Gas Appliance Manufacturers' Association (GAMA), and the Bureau of Product Safety (BPS) of the Food and Drug Administration. NBS presented the group with a report on ignition sources of fabric fires which indicated that over a third of the garment fires studied were caused by ranges.[1] In January 1972 additional evidence was presented to them in a BPS study showing the ignition of garments by electric ranges in 20 Boston accidents.[2]

In April, NBS showed industry representatives the results of an additional study by NBS contractor Trident Engineering Associates, Inc., in which eight safety design features were recommended.[3] At that time, NBS requested the American Gas Association Laboratories (AGAL) through A.G.A. and the UL (representing the gas and electric range certifying organizations) to consider a joint contract to develop performance criteria for ranges of optimum safety. In reviewing these suggested design changes and concepts, UL and AGAL were to prepare trade-off analyses of ex-

NBS Fire Research experiment shows mannikin's sleeve catch fire as its arm extends over range (left), and the resulting flame (right). The test measures the flammability of the fabric and at the same time demonstrates the ease with which ranges can ignite clothing.

ANDARDS

pected improvements in safety *vs.* expected costs and other negative factors should the Trident recommendations be adopted.

On May 1, A.G.A. and UL agreed to sponsor programs to review and evaluate the recommendations, to conduct flammability tests and trade-off analyses, and to prepare conceptual gas and electric range designs, if justified. Close coordination was to be maintained by NBS.

NBS continued to meet with these groups and with individual company representatives in order to review progress, to reach agreement, and to keep the industry informed. In the process, emphasis shifted from design standards toward performance standards.

NBS has reviewed the preliminary UL and AGAL reports and coordinated their recommendations. According to the reports, the kitchen range industry is considering the adoption of the following steps toward improved safety:

·Offering consumer education in the proper use of a range to avoid garment ignitions.

·Recommending elimination of cabinets over ranges. Locating range convenience receptacles, knobs, and other controls so that the user does not have to reach near burners to operate controls.

·Lessening the likelihood of "accidental turn on" of top burner controls by requiring dual acting controls.

·Minimizing accidents caused by "leaning against" or "being near" ranges by requiring a minimum setback of all surface burners.

·Providing means for limiting the gas flames and hot electric elements to areas covered by utensils and including a performance test for measuring the likelihood of fabric ignition by range burners.

Once standards have been upgraded, NBS will evaluate the specified improvements by having prototype ranges constructed and subjecting them, alongside existing ranges, to use studies. Numerical ratings will be developed to attempt to describe the degree of reduction in risk accomplished.

The National Bureau of Stan-

dards is involved in three other programs related to this range safety program. The Man Made Fiber Producers Association and the American Apparel Manufacturers Association each sponsor a Research Associate in the Fire Technology Division (FTD) studying the mechanisms of ignition of fabrics and garments, respectively, by ignition sources such as the kitchen range.

The FTD serves as chairman of a Goverment Industry Research Committee on Fabric Flammability, which is responsible for four theoretical and applied research studies of the mechanisms of ignition and burning conducted by the Factory Mutual Research Corp., the Georgia Institute of Technology, the Gillette Research Institute, and the Massachusetts Institute of Technology. This program is jointly funded by the National Science Foundation, the Man Made Fiber Producers Association, American Textile Manufacturers Institute, and Cotton, Inc.

The NBS Product Evaluation Technology Division and the Bureau of Product Safety are working with the kitchen range industry to develop maximum permissible temperature requirements for surfaces other than the burners on ranges. These will be incorporated in existing range standards through normal voluntary standards writing procedures.

[1] Tovey, H., and Giroux, R. R., Ignition sources in accident cases involving flammable fabrics, Nat. Bur. Stand. (U.S.), NBS Report 10-269, Nov. 11, 1971, Washington, D.C. 20234.

[2] Domestic Electric Ranges and Clothing Ignition, Boston Injury Study Unit, U.S. Public Health Administration, Food and Drug Administration, Jan. 27, 1972.

[3] Study of Clothing Ignition Hazards from Gas and Electric Ranges, Trident Engineering Associates, Inc. Order No. S-212782, May 22, 1972, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. 20234.

DEVICE *continued*

reproducible transitions did occur, as indicated by a set of germanium resistance thermometers. Over a 3-year period, they studied the effects of thermal cycling and of mutual inductance bridge parameter variations on the transitions occurring in a group of five of the devices. These tests showed that the resulting fixed points were reproducible to within ± 1 mK, therefore production of devices for general use could be started. It would have been desirable to let interested users construct their own devices using an NBS "recipe," but the necessity for careful annealing of the zinc and cadmium samples made that option a rather difficult one.

Values of the various transition temperatures were derived from paramagnetic salt thermometry in conjunction with the T_{62} ^{3}He vapor pressure-temperature scale or with the NBS 2-20 K acoustical temperature scale. In the former case, the set of germanium resistors was calibrated at several temperatures against readings taken in a ^{3}He vapor pressure bulb, and the paramagnetic susceptibility of a cerous magnesium nitrate single-crystal sphere was used to evaluate the Zn and Cd transition temperatures. The germanium resistances corresponding to the Al transition were evaluated directly against the ^{3}He bulb temperature. The Pb and In transition temperatures were obtained by paramagnetic salt thermometry interpolation between points of germanium resistors that had been calibrated on the NBS 2-20 K scale.

Immediate NBS plans call for one device to be installed in the NBS acoustic thermometry apparatus, on which the NBS 2-20 K scale was developed. The lead and indium transition temperatures will then be measured directly on that scale, which is quite widely used in cryogenic thermometry.[4] A second set has been installed in the NBS Josephson junction noise thermometer cryostat,[5] so that the aluminum, zinc, and cadmium transition temperatures can be evaluated directly on that scale. Other sets have been ordered by national standards laboratories in other countries and by university scientists.

Table I. **Uncertainty and Reproducibility of Assigned Transition Temperatures of Superconductive Samples**

Element	Assigned Transition Temperature (K)	Derivation	Assignment Uncertainty (mK)	Experimental Reproducibility (mK)
Lead	7.201	(NBS 2–20 K) + salt thermometry	2.5	0.32
Indium	3.416_7	(NBS 2–20 K) + salt thermometry	1.5	0.15
Aluminum	1.174_6	Direct Calib. —^{3}He v.p. T_{62}	2.	0.28
Zinc	0.844	T_{62} + salt thermometry	1.5	0.22
Cadmium	0.515	T_{62} + salt thermometry	2.5	0.30

[1] Schooley, J. F., Soulen, R. J., Jr., and Evans, G. A., Jr., Preparation and Use of Superconductive Fixed Point Devices, SRM 767, NBS Spec. Pub. 260-44, 35 pages (Dec. 1972). Order by SD Catalog No. C13.10:260-44 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 75 cents.

[2] Superconductive transitions suitable for thermometric fixed points, Nat. Bur. Stand. (U.S.), Tech. News Bull. **55**, No. 2, p. 39 (1971).

[3] SRM 767 may be purchased from the Office of Standard Reference Materials, Room B314, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234, for $250.

[4] Acoustical thermometer establishes provisional low-temperature scale, Nat. Bur. Stand. (U.S.), Tech. News Bull. **48**, No. 11, p. 189 (1964).

[5] Soulen, R. J., Jr., and Marshak, H., The use of Josephson junctions for noise thermometry below 1 kelvin, Proc. 1972 Applied Superconductivity Conference, p. 588 (1972).

Dr. William Anderson, Presidential Intern, University of Missouri, operates the voltage source controls of the NBS self-balancing reactance bridge, the first of its kind. The device was developed by Oskars Petersons of NBS, with the aid of Dr. Anderson, Walter Mangan, and Ronald Stanley.

SHUNT REACTOR POWER LOSS

Bureau scientists have developed, constructed, and tested a new system for measuring power losses of shunt reactors conveniently and accurately.

Shunt reactors are large transformer-like devices connected to high voltage transmission lines. They "tune out" undesirable charging currents and thus expedite transmission of power from points of generation to load centers. Tuning produces more stable and safer electric systems, thereby helping prevent system failures, better known as blackouts. Accurate measurement of losses insures more efficient and reliable reactors and thus more power and savings to the consumer's pocketbook and to the Nation's economy.

About 30 shunt reactors are sold annually in the United States at a total estimated cost of about $5 million, and almost all electricity transferred more than 150 miles flows through transmission lines compensated by reactors.

Shunt reactors are now used hundreds of miles apart on overhead transmission lines. But if it becomes necessary to transmit electric power over long distances in underground cables, shunt reactors would be needed every 20 or 30 miles.

The new NBS measurement system was designed by Oskars Petersons, Chief of the NBS High Voltage Measurements Section. It is to be used in conjunction with commercially available compressed gas capacitors and it consists of a self-balancing high voltage bridge, precision operational amplifiers, and an electronic wattmeter. With the new system, power loss can now be measured electrically to an accuracy of 0.001 percent of the total power (circulating and lost) and to 0.5 percent accuracy of the lost power itself. The equipment is simple to operate and measurements can be performed quickly.

Shunt reactors are highly efficient, making loss measurements impossible to perform by conventional electrical methods. The calorimetric method of measurement (the old method) yields sufficient accuracy but is difficult, time consuming, and costly.

Immediate benefits of the new method will go to the manufacturers through savings in manpower and time required to perform tests. But because the price of a reactor is strongly influenced by the value of electric energy dissipated during its lifetime—about $100,000—improved measurements will also aid the manufacturers in developing more realistic design modifications, and in selecting materials and techniques to improve reliability and reduce losses. At the same time, buyers of reactors will no longer need to place sole reliance on the manufacturer's test data.

Until now, reactors have been tested only by manufacturers at the time of their transfer to the user. The new method opens up the possibility of field testing the reactors at the place of installation for indications of degradation after years of service. The new equipment can also be used to measure power losses in large capacitors, such as power factor correction capacitors and long high voltage cables.

In conjunction with the new equipment, NBS offers a calibration service for shunt reactors and large capacitors. Calibrations can be performed either on manufacturer's or user's premises.

The panoramic x-ray machine, which takes a single photograph of the entire dental arch in less than a minute, was developed at NBS in the 1950's. Over $30 million worth of these machines have been sold by private U.S. industry.

NBS AND THE INVENTOR

February 11 was both the 126th anniversary of Thomas Edison's birth and the first observance of National Inventors Day, officially established by action of the President and Congress.

Facing unprecedented challenges in such crucial areas as environmental quality, energy, natural resources, transportation, housing, communications, and others, the Nation is giving recognition and encouragement to inventors and innovators who must keep the light of progress burning.

For NBS, National Inventors Day had special significance. For nearly 75 years NBS has been a basic resource for the scientific and technological community. The Bureau maintains ties with leading inventors and innovators, even as it did with "the wizard of Menlo Park" himself.

Edison's first acquaintance with NBS came about when he tried to invent the already existing Bureau. He proposed—around 1915, 14 years after the agency's founding—that the government establish a fundamental research laboratory. Edison got to know NBS and in one of his letters singled out an NBS publication—*The Principles Underlying Radio Communication*—as "the greatest book on this subject that I have ever read."

In discovering and developing underlying principles, NBS helps to foster invention and innovation and in the natural course of its work, the Bureau creates improved instruments, devices, and processes, which are made readily available to the country's industry and technology. Some recent contributions by the Bureau include: a magnetic method for detecting cancer in a living animal; a variety of air and water pollution monitoring devices; new dental adhesive and filling materials; a diamond-anvil pressure cell for studying the behavior of matter under extreme pressures which is used for purposes ranging from crystal-structure studies to laboratory analysis of criminal evidence; a scanning thermal detector, sensitive enough to detect a person entering a room at more than 50 feet or to sense minute changes in the temperature of a piece of equipment; a new technique for welding high-vacuum equipment; and many others.

NBS concern with creativity in science and technology became explicit and official as the Bureau worked with the World War II-generated National Inventors Council and subsequently established the NBS Office of Invention and Innovation, for which the Council is now the advisory body. Jacob Rabinow, well known for his invention of the magnetic fluid clutch during his early NBS days and his stream of inventions and new-technology business ventures in many fields, has returned to NBS to direct the OI&I. Under his guidance, this NBS unit works within the Federal Government to establish programs and policies conducive to invention and innovation, serves as planner and co-sponsor of state and community inventors' expositions, cooperates with colleges and universities on improved methods of education for innovation, and provides a contact and referral point for inventors and entrepreneurs starting out on the long, rocky road that leads from conception of a new idea to the actual marketing of an innovative device or product.

The Department of Commerce itself currently has custody of some 250 active patents which are available for licensing to private industry. Most of these patents cover inventions developed at the National Bureau of Standards. Through publications and personal contact, NBS encourages early use of its achievements for the public benefit.

NBS SIGNALS AID POWER COMPANIES

NBS time and frequency radio broadcasts are helping reduce the likelihood of widespread electrical brownouts in the United States.

America's power systems operate as a single nationwide interconnected network encompassing about 94 percent of U.S. generating capacity. Each utility shares in the obligations of interconnection: adjusting power generation levels to match load changes, providing timely power transfers from one utility to another, and assisting neighbors during periods of need.

As the use of energy grows, as large utilities sell power back and forth, the need grows for an accurate way to measure power use. One great problem of power companies today is to keep frequency synchronized with load. Precise frequency and time standards are required by interconnected utilities to avoid inadvertant tie line energy flows. Such energy flows cause unnecessary losses in transmission lines, create unnecessary generating burdens, and lead to instabilities and breakdowns.

NBS time and frequency signals, broadcast from station WWVB (Fort Collins, Colo.) are essential to this task. The NBS standards can also help track down power failures quickly so they can be localized. They contribute to the stability of the entire chain, minimizing the risk of local power failure suddenly cascading into power interruption over wide geographic areas.

Proper readjustments of generator frequencies against high accuracy clocks (better than 1 millisecond) insure proper total power transfers in the system. The frequency information, used to see that the frequency stays at 60 hertz, frees up "discretionary energy" and increases reserve margins.

A direct path, with no time delays, to the signals' receiving areas provides more ready reception at distant points without undue difficulty. This allows for measurement to be the same in all areas of interconnection. This also simplifies corrections, cutting down on error and delay caused by oral and written communications which are normally a part of a cumbersome notification network for spreading time error information. These problems are neatly solved through the use of the time-code broadcasts of NBS radio station WWVB.

As demand for energy continues to climb, it is expected that the value of the broadcasts will grow.

NBS AIDS HOSPITAL DESIGNERS

To help administrators and architects in the early stages of planning hospitals, the Bureau has developed a method for selecting bedroom and nursing unit designs appropriate not only for patient and staff needs but for visitors as well.

The work was done for the Department of Health, Education, and Welfare (HEW), under the direction of Dr. Robert Wehrli and Robert Kapsch of the NBS Center for Building Technology.

The newly devised method consists of a system for deriving criteria, a technique for scoring, and a sample set of scorecards. The results of two simulated evaluations, in which specially designed schemes were scored by an architect and a physician, proved the method's utility.

A report on this project, available from the Health Services and Mental Health Administration, HEW, also compares literature and design ideas on how the nursing unit, and its chief element—the patient's bedroom—should be planned, designed, and constructed.[1]

[1] Wehrli, R., Kapsch, R., Hospital Bedrooms and Nursing Units—A Systems Approach Center for Building Technology, National Bureau of Standards, September 1, 1972. Copies may be obtained from the National Center for Health Services Research and Development, Health Services Mental Health Administration, U.S. Department of Health, Education, and Welfare, 5600 Fishers Lane, Rockville, Md. 20952.

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

ALLOY DATA CENTER TAPE AND DOCUMENTATION PARCEL

The NBS Alloy Data Center (a part of the National Standard Reference Data System) has developed an automated system for retrieving papers indexed for internal use. Papers have been deep-indexed and the codes punched on 80 column cards in fixed-field format. These card images are put on a magnetic tape called the Biblio-Master-File. The search system and data file are now available to the public.

NBS Magnetic Tape 3 is a copy of the Biblio-Master-File and contains all of the data in the files as of January 1973. The tape contains blocked card images, nine 80-character cards to a record. The following information is available on the tape: the first author and journal citation; main experimental technique; physical properties, usually in order of importance; materials studied (metals and alloys, up to quaternary); material composition (in atomic percent); and temperature (absolute scale) at which the work was performed.

The format of the card image and codes used are described in NBS Technical Note 464, which is part of the documentation supplied in this tape parcel. The data on the Biblio-Master-File was reformatted to produce *The NBS Alloy Data Center Permuted Materials Index* and *The NBS Alloy Data Center: Author Index.*

The documentation for the parcel may be purchased separately. Items include: NBS Technical Note 464, *The NBS Alloy Data Center: Function, Bibliographic System, Related Data Centers, and Reference Books,*[1] (SD Catalog No. C13.46:464, $1.25, Aug. 1968); NBS Special Publication 324, *The NBS Alloy Data Center: Permuted Materials Index,*[1] (SD Catalog No. C13.10:324, $7, Mar. 1971); NBS-OSRDB-70-2, *The NBS Alloy Data Center: Author Index,*[2] (NTIS Catalog No. COM-71-00722, $10, Dec. 1970).

The magnetic tape and the supporting documentation can be purchased for $250 from the National Technical Information Service, Springfield, Va. 22151.

Parcel recipients are asked to return the registration card to:

Office of Standard Reference Data
National Bureau of Standards
Washington, D.C. 20234

LINE AND BAND EMISSION CROSS SECTION DATA

Appendix B of *Proceedings of the Workshop on Dissociative Excitation of Simple Molecules* held March 16-17, 1972, at the Joint Institute for Laboratory Astrophysics, University of Colorado, Boulder, Colo., contains a compilation entitled, "Line and Band Emission Cross Section Data for Low Energy Electron Impact," by Lee J. Kieffer. This is a compilation of cross sections for emission of radiation by fragments resulting from the dissociation of simple molecules by impact of low-energy electrons. Both atomic lines and molecular bands are included. Most data are presented in a standardized graphical format. The *Proceedings* was published as JILA Information Center Report No. 12, June 1, 1972.

TWO RECENT NBS LISTS OF PUBLICATIONS IN CHEMICAL KINETICS

The latest NBS Lists of Publications from the Chemical Kinetics Information Center are No. 69, dated July 1972, *Chemical Kinetics of Reactions of Chlorine, Nitrogen and Oxygen Fluorides in Gas Phase: A Bibliography—1934 through June 1972* and No. 70, dated July 1972, *Reactions of Electronically Excited Molecular Oxygen (with Organic and Inorganic Molecules) in Liquid Phase.* The material in List No. 69 is arranged by chemical reaction in three separate lists—chlorine fluorides, nitrogen fluorides, and oxygen fluorides. There are 60 reactions in the lists based on work in 51 papers. List No. 70 is divided into two parts—research papers and reviews. Most papers deal with O_2 in excited singlet states ($a^1\Delta_g$, or $b^1\Sigma_g+$). Both Lists are based on the files of the Chemical Kinetics Information Center and an examination of *Chemical Abstracts.* The Lists are

available without cost from the Chemical Kinetics Information Center, Room B158, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234.

KINETIC DATA FOR HIGH TEMPERATURE REACTIONS

Evaluated Kinetic Data for High Temperature Reactions, Volume 1: Homogeneous Gas Phase Reactions of the H_2-O_2 System by D. L. Baulch, et al., has recently been published. The data center at Leeds University, which prepared this book, is supported by the United Kingdom Office of Scientific and Technical Information and is informally linked with the NBS Chemical Kinetics Information Center.

The thermodynamic data for each reaction and its reverse are recorded, together with all available reaction rate measurements, which are displayed in tabular and graphical form. The data are critically evaluated and discussed, and, whenever possible, a rate expression is derived. The error limits and conditions under which the recommended rate parameters are applicable are defined.

This work is primarily intended for reference and particular attention has been paid to the format. For each reaction a recommended rate expression is given. Extensive bibliographies have been provided for the specialist in sufficient detail to enable an independent assessment to be made.

The reactions considered were selected by a panel consisting of representatives from industry, government research establishments, and universities. The reactions covered in this volume are of importance in combustion and air pollution research, upper-atmosphere studies, re-entry problems, and high-temperature systems generally. As such they will be of use to chemists, physicists, and mechanical and chemical engineers.

Volumes scheduled for future publication are: *Homogeneous Gas Phase Reactions of the N_2-O_2 and H_2-O_2-CO Systems* and *Homogeneous Gas Phase Reactions of the H_2-N_2-O_2 and H_2-O_2-S Systems.*

Evaluated Kinetic Data for High Temperature Reactions, Volume 1, may be purchased from The Chemical Rubber Co., 18901 Cranwood Parkway, Cleveland, Ohio 44528, for $36.

ACTIVATION ANALYSIS: A BIBLIOGRAPHY THROUGH 1971

NBS Technical Note 467, *Activation Analysis: A Bibliography Through 1971* edited by G. J. Lutz, R. J. Boreni, R. S. Maddock, and J. Wing[1] (SD Catalog No. C13.46:467, $7), is the fourth issuance of a bibliography that first appeared in 1968. It is planned to continue updating and reissuing the volume periodically as long as the literature of activation analysis (chemical analysis based on detection and measurement of the radiation produced when a sample is bombarded by nuclear projectiles) continues its growth. At present, new titles are appearing at the rate of about 1,000 a year; the accumulated total in this edition is approximately 6,200. As before, the bibliographical entries, identified by accession numbers, are given in Part 1. Part 2 gives access to the references listed in Part 1 through four indexes: Author, Element Determined, Matrix Analyzed, and Technique Utilized.

THERMOPHYSICAL PROPERTIES OF HELIUM-4 FROM 2 TO 1,500 K WITH PRESSURES TO 1,000 ATMOSPHERES

NBS Technical Note 631, *Thermophysical Properties of Helium-4 from 2 to 1,500 K with Pressures to 1,000 Atmospheres* by Robert D. McCarty[1] (SD Catalog No. C13.46:631, $1.25), is a republication of NBS Technical Note 622, *Thermophysical Properties of Helium 4 from 4 to 3,000 R with Pressure to 15,000 PSIA*, with the table and chart values converted to SI units, except for pressure and viscosity, which are given in atmospheres and poises for reasons of utility. It assembles data on many of the properties of helium commonly used in engineering calculations, and covers as wide a temperature and pressure range as is practical. Each table of values has been critically evaluated and represents the "best value" available at this time.

Helium 4 properties have been of great interest to science and engineering for years, but much of the work has been devoted to the more spectacular properties of helium II, the superfluid phase. These tables do not include superfluid properties, except for the pressure-density-temperature table where the transition to superfluidity begins. Isobaric tables include entropy, enthalpy, internal energy, density, volume, speed of sound, specific heat, thermal conductivity, viscosity, thermal diffusivity, Prandtl number and the dielectric constant, plus tables of quantities of special utility in heat transfer calculations. There are also tables of the above properties (and one of surface tension) for the saturated vapor and liquid, and tables for various other properties such as index of refraction and Joule-Thomson curve.

COMPUTER PROGRAMS FOR THERMODYNAMIC AND TRANSPORT PROPERTIES OF HYDROGEN

NBS Technical Note 625, *Computer Programs for Thermodynamic and Transport Properties of Hydrogen (Tabcode-II)* by H. M. Roder, R. D. McCarty, and W. J. Hall[1] (SD Catalog No. C13.46:625, $1.75), gives computer routines for calculating the thermophysical properties of hydrogen. Given as input data the pressure and temperature or pressure and enthalpy of

parahydrogen or equilibrium mixtures of para- and ortho-hydrogen, one may obtain the following as output: enthalpy or temperature, density, entropy, thermal conductivity, viscosity, velocity of sound, heat capacity C_p, heat capacity C_v, heat capacity ratio, and a commonly used heat transfer parameter called the L-factor. The programs achieve high speed by using linear interpolation, and charts of maximum errors for each routine are supplied along with estimates of error in the source data. The ranges of pressure, temperature, and enthalpy covered by the programs are 1 to 5,000 psia, triple point to 6,000 °R, and −130 to 25,000 BTU/lb_m.

STANDARD X-RAY DIFFRACTION POWDER PATTERNS

NBS Monograph 25, Section 10, *Standard X-Ray Diffraction Powder Patterns* by H. E. Swanson, H. F. McMurdie, M. C. Morris, E. H. Evans, and B. Paretzkin[1] (SD Catalog No. C13.44:25/10, $2), is the 20th[3] in a series of compilation of x-ray diffraction patterns data for use by chemists and others in identifying crystal-line materials by matching d-spacing and diffraction line intensities. The program that generates this information also aids in evaluating and revising published x-ray data and in developing diffraction techniques. In this installment, standard patterns are given for 84 substances—47 obtained with an x-ray diffractometer, the others calculated. All d-values were assigned Miller indices by comparison with computed interplanar spacings consistent with space group extinctions. Densities and lattice constants were calculated, and line refractive indices were measured wherever possible. The calculated patterns were computed from published crystal structure data; both peak height and integrated intensities are reported. The experimental work and calculations on which the publication is based were performed at NBS by Research Associates of the Joint Committee on Powder Diffraction Standards (JCPDS) in cooperation with NBS scientists. The JCPDS is supported by a group of nine scientific associations in Great Britain, France, Canada, and the United States.

LIQUID DENSITIES OF OXYGEN, NITROGEN, ARGON, AND PARAHYDROGEN

NBS Technical Note 361 (Revised), *Liquid Densities of Oxygen, Nitrogen, Argon, and Parahydrogen* by H. M. Roder, R. D. McCarty, and V. J. Johnson[1] (SD Catalog No. C13.46:361 (Revised), $1.50), presents tables of pressure, volume, density, and temperature for the saturated liquid and compressed liquid states of oxygen, nitrogen, argon, and parahydrogen. The range of values covered extends from the triple point to the critical point for each liquid, and values are listed in several units: Rankine and kelvin for temperature; atmospheres and psia for pressure; gram-mole per cubic centimeter, pounds (mass) per cubic foot, and pounds (mass) per gallon for density; etc. These units were chosen as the most commonly used in the industries involved.

This work extends the data available in the original Technical Note 361 to the compressed liquids, and also includes new data on oxygen. However, values do not differ from the earlier work by more than 0.16 percent.

In addition to tables, there are graphs of the specific volume and liquid volume correction factor versus pressure for saturated and compressed liquids, estimates of errors, and a discussion of the sources and limitations of the data.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

[2] Available from the National Technical Information Service, Springfield, Va. 22151, for the price indicated.

[3] NBS Monograph 25, Sections 4 thru 10 are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, as follows: NBS Monograph 25, Section 4, 55 cents; Section 5, 55 cents; Section 6, 60 cents; Section 7, $1.50; Section 8, $1.50; and Section 9, $1.25. Remittance from foreign countries should include an additional one-fourth of the purchase price for postage. Order by SD Catalog No. C13.44:25/Sec. The following "out of print" copies may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151. These publications will be identified with a "PB" number which must be used in ordering. The publications are $6 each hardcopy and 95 cents each microfiche. Foreign countries should include an additional $2.50 for each hardcopy and $1.50 for each microfiche for postage.

NBS Publication Number	PB Number
Circular 539, Vol. 3	178 904
Circular 539, Vol. 4	178 905
Circular 539, Vol. 6	178 907
Circular 539, Vol. 7	178 908
Circular 539, Vol. 9	178 910
Mono. 25, Sect. 1	178 429
Mono. 25, Sect. 2	178 430
Mono. 25, Sect. 3	178 431

OR NEWS *continued*

further goals not discussed above. These projects are necessarily dependent upon changing needs in the electro-optics community, available manpower and funding, and unanticipated discoveries in electro-optics technology which could alter the state of the art. Some of these include radiometric and photometric standards of pulsed sources, very low level sources, LED's, fluorescent and metal additive lamps; standard measurement procedures for geometrically total spectral flux of line sources; realization of the candela with an ECR and V_λ filter, comparison of the radiometric *vs.* photometric realization of the candela, and possible redefinition of the candela; and infrared standards and calibrations of large area sources.

[1] Steiner, B., The Impact of Radiometry and Photometry and the Role of NBS, Nat. Bur. Stand. (U.S.) Tech. Note 594-4 (1973). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 80 cents. Use SD Catalog No. C13.46:594-4 when ordering.

[2] See Optical Radiation News in the October and December 1972 Technical News Bulletins.

[3] Burns, V. I., and McSparron, D. A., Photometric calibration procedures, NBS Tech. Note 594-3, 60 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; SD Catalog No. C13.46:594-3.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Annual subscription: Domestic, $6.50; foreign, $8.25 Single copy price, 65 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $17.00; foreign, $21.25. Single copy price varies. SD Catalog No. C13.22/sec.A.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $9; foreign, $11.25. Single copy, $1.25. SD Catalog No. C13.22/sec.B.

NBS BIBLIOGRAPHIC SUBSCRIPTION SERVICES

Cryogenic Data Center Current Awareness Service (Publications and Reports of Interest in Cryogenics). A literature survey issued weekly. Annual subscription: Domestic, $20.00; foreign, $25.00.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: $20.00.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: $20.00. Send subscription orders and remittances for the preceding bibliographic services to the U.S. Department of Commerce, National Technical Information Service, Springfield, Va. 22151.

Electromagnetic Metrology Current Awareness Service (Abstracts of Selected Articles on Measurement Techniques and Standards of Electromagnetic Quantities from D-C to Millimeter-Wave Frequencies). Issued monthly. Annual subscription: $100.00 (Special rates for multi-subscriptions). Send subscription order and remittance to the Electromagnetic Metrology Information Center, Electromagnetics Division, National Bureau of Standards, Boulder, Colo. 80302.

OTHER NBS PUBLICATIONS

TN627. **Computation of spectral data for a Josephson junction circuit,** E. G. Johnson, Jr. and D. G. McDonald, Nat. Bur. Stand. (U.S.), Tech. Note 627, 63 pages (Nov. 1972) 60 cents, SD Catalog No. C13.46:627.

TN629. **Superconducting quantum interference devices: An operational guide for rf-biased systems,** D. B. Sullivan, Nat. Bur. Stand. (U.S.), Tech. Note 629, 47 pages (Nov. 1972) 50 cents, SD Catalog No. C13.46:629.

TN630. **Developments in cryoelectronics,** R. A. Kamper and D. B. Sullivan, Nat. Bur. Stand. (U.S.), Tech. Note 630, 73 pages (Nov. 1972) 70 cents, SD Catalog No. C13.46:630.

TN735. **The effects of magnetic fields on magnetic storage media used in computers,** S. B. Geller, Nat. Bur. Stand. (U.S.), Tech. Note 735, 35 pages (July 1972) 40 cents, SD Catalog No. C13.46:735.

PUBLICATIONS IN OTHER JOURNALS

This column lists all outside publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time. The five-digit number at the beginning of each entry is used for record keeping only and should not be used when requesting reprints or other information.

13080. Hougen, J. T., **On a vibration-rotation Hamiltonian for bimolecular collisions analogous to the Wilson-Howard vibration-rotation Hamiltonian for isolated molecules,** *J. Chem. Phys.* **56,** No. 12, 6245-6250 (June 15, 1972).

13081. Steiner, B., **Photodetachment of S^-: Behavior of the cross section above threshold,** Paper in *Sixth International Conference on the Physics of Electronic and Atomic Collisions, Massachusetts Institute of Technology, Cambridge, Massachusetts, July 28-Aug. 2, 1969, Abstracts of Papers, Session C-8,* pp. 535-537 (Massachusetts Institute of Technology Press, Cambridge, Mass., 1969).

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